B6800-1A

NUEXCO

DECEMBER 1985 NUMBER 208

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

NUEXCO

HEADQUARTERS

Three Park Central
1515 Arapahoe Street
Suite 1045
Denver, Colorado 80202
Telephone: (303) 893-4015
Telecopy: (303) 825-4821
Telex: 450202 (NUEXCO DVR)

Managing Director
Oren L. Benton

NORTHEAST UNITED STATES

100 Prospect Street
Century Plaza South
Stamford, Connecticut 06901
Telephone: (203) 323-1999
Telecopy: (203) 325-1483
Telex: 4750124 (NUEXCO C)

Managing Broker
Earl E. Hoellen, Jr.

SOUTHEAST UNITED STATES

Suite 905
Ten Piedmont Center
Atlanta, Georgia 30305
Telephone: (404) 262-7375
Telecopy: (404) 233-6210
Telex: 4611142 (NUEX ATL)

Managing Broker
M. Jerry Reaves

WESTERN UNITED STATES

Building 3, Suite 290
3000 Sand Hill Road
Menlo Park, California 94025
Telephone: (415) 854-1510
Telecopy: (415) 854-2115
Telex: 470674 (NUEXCO UI)

Managing Broker
George White, Jr.

EUROPE

13 chemin du Levant
01210 Ferney-Voltaire
France
Telephone: (33-50) 428035
Telecopy: (33-50) 428526
Telex: 385288 (NUEXCO F)

Managing Broker
James E. Vaughan

REGIONAL MANAGING BROKERS

AFRICA
James E. Vaughan

AUSTRALIA
George White, Jr.

CANADA
Wayne D. Fowler

EUROPE
James E. Vaughan

FAR EAST
Christian C. Guitton

(See inside back cover for list of Representatives and Consultants)

NUEXCO

MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

December 1985 No. 208

GEORGE WHITE, JR., *EDITOR* CLARK M. BEYER, *ASSOCIATE EDITOR*

PRICING
Natural Uranium and Conversion 1
Enriched Uranium and SWUs 2

CURRENT MARKET DATA
Nuexco Market Data Table 3
Prices Expressed in Selected Currencies 4
Recent Transactions 6
Supply and Demand Tables 7

FOCUS
Belgium 11

RECENT DEVELOPMENTS
Australia 16

RAW MATERIALS
Surficial Uranium Deposits—Part 1 17

HISTORICAL MARKET DATA
Graph of Exchange Value and Transaction Value 21
Historical Exchange Value, Transaction Value and Conversion Value ... 22

GOVERNMENT STATISTICS
Australia 23
Canada 24
South Africa 25
United States 26

NOTICE

This Report is prepared especially for Subscribers and is furnished to them for their use only. Except for internal use by Subscribers, no part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of Nuexco. Neither this Report, nor copies of any portion thereof, may be lent, sold or given to non-subscribers.

The information in this Report was gathered from sources Nuexco believes to be accurate. However, Nuexco makes no warranty, express or implied, and assumes no legal liability or responsibility for the accuracy, completeness or usefulness of any information contained herein.

© NUEXCO 1985

To Our Readers

Included with this Report is a slightly edited version of a speech presented by George White, Jr., at the Atomic Industrial Forum's Annual Conference in San Francisco, California on November 11, 1985.

* * *

Nuexco's US offices will be closed for the holidays on Wednesday, December 25, and Wednesday, January 1, 1986. Our Europe office will be closed from December 23 through January 1.

© NUEXCO 1985

NATURAL URANIUM AND SECONDARY MARKET CONVERSION

(All data as of November 30, 1985)

The **Exchange Value** is **$16.75** per pound U_3O_8, up $0.25 since last month. **Active supply** of natural uranium (U_3O_8 and UF_6) for spot or near-term delivery totals **3,615,000** pounds equivalent U_3O_8 as concentrates or UF_6, up 405,000 pounds since last month. The corresponding figure for **active demand** is **2,270,000** pounds, up 1,375,000 pounds. The spot and near-term **supply-demand ratio** fell to **1.6:1.**

The *Current Market Data* section of this Report lists one natural uranium sales transaction, involving approximately 100,000 to 300,000 pounds U_3O_8. It involved near-term delivery, and also met the criteria for inclusion in the current Transaction Value calculation. Several other transactions aggregating more than 300,000 pounds U_3O_8 were in the final stages of negotiation, but did not meet the criteria for reporting as of the end of the month.

The **Transaction Value** is **$15.80** per pound U_3O_8, up $0.05 since last month.

The **UF_6 Value** is **$46.00** per kilogram U in UF_6, unchanged since last month.

The **Conversion Value** is **$1.60** per pound U in UF_6, unchanged since last month. No active supply or demand of secondary market conversion services for delivery within three years is reported, and no secondary market conversion transactions are reported in that dormant market.

The **Loan Use Charge Rate** is unchanged at **5 percent** per annum, as both lenders and borrowers continue to express their interest in doing business at that level.

* * *

The Exchange Value rose slightly as overall market firming continued in this relatively quiet month. Lacking any downward pressure from distress sellers, the market edged higher as most sellers refused commitments at previous price levels. Some new demand entered the market, much of which was for longer-term requirements. Similar to last month, a wide range of offering prices is in effect; smaller quantities are available at slightly below $16.75, but larger quantities cannot be obtained at that level.

The UF_6 Value was unchanged, indicating that the availability of UF_6 continues to hold the price of UF_6 below the algebraic sum of the Exchange Value and Conversion Value. Based on the demand for and prices of U_3O_8, and the supply and prices of UF_6, it can be anticipated that *any* new demand for secondary market conversion services would likely be met through deconversion swaps at prices below the current Conversion Value, provided it is possible to match location and timing.

For the past several months, non-US currencies generally have risen against the US dollar. This trend was again evident during November. The slight rise in the Exchange Value (expressed in US dollars) did not overcome the dollar's decline, and the Exchange Value actually fell in most non-US currencies. The net effect was to discourage non-US sellers of spot or near-term material.

* * *

While the Exchange Value has advanced $2.50 per pound U_3O_8 from its April 1985 low of $14.25, it has yet to recover to the September 1984 level ($17.50) at which the present cycle began. Thus, while prices are up from their lows, reference to the Exchange Value graph on page 21 might suggest that prices are still at what could be described as "bargain" levels. Based on current spot price levels and attainable financing rates, it is easily calculated that it is more economical to purchase and hold uranium for use as late as 1990 or 1991 than to purchase the same material for delivery in those later years at currently attainable base prices plus assumed escalation. Presuming a reasonable level of market efficiency, this anomaly cannot continue indefinitely and will likely be the mechanism that will close the gap between spot prices and prices for longer-term delivery.

The two major uncertainties in the marketplace remain unresolved — the court decision ruling the US enrichment contract null and void, and DOE's finding that the US uranium industry is not viable. Litigation settlement proposals put forth by the US uranium producers have been rejected by DOE. To date the chief market response to these two events appears to be the attitudes of US producers, who have expressed renewed optimism regarding the future and are reluctant to enter transactions at current price levels. Conversely, utilities generally seem prepared to wait for these events to be resolved rather than taking action based on conjecture. It has been suggested that there may be some link between these events and recent inquiries by a number of utilities for long-term

© NUEXCO 1985

PRICING

uranium supply. However, while the timing is somewhat coincident, these inquiries first began to appear some months ago, before the actions by the federal court and DOE, and are a predictable consequence of the general market perception that the prices were at or near their lows.

* * *

ENRICHED URANIUM AND SWUS

The Nuexco **SWU Values** as of November 30, 1985 are:

1. For **DOE origin,** a tails assay of 0.30 weight-percent U_{235}, for delivery by the end of FY86, and certifiable as excess, $78 per SWU, down $5.

2. For **other** SWUs (includes DOE origin SWUs not certifiable as excess and non-DOE origin SWUs), for delivery by the end of calendar year 1986, $78 per SWU, down $5.

One secondary market SWU transaction is reported this month, as both the DOE-certifiable SWU Value and non-DOE or non-certifiable SWU Value fell. Competition for the few remaining opportunities applied downward pressure on prices. Although some potential transactions currently are in negotiation, there is no active demand for SWUs in the near-term. Because of the convergence of the markets, any future supply of certifiable SWU will have to be marketed in competition with non-DOE origin SWU.

© NUEXCO 1985

CURRENT MARKET DATA

November 30, 1985	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$16.75**/lb. U_3O_8	3,615	2,270
UF_6 VALUE	**$46.00**/kgU		
CONVERSION VALUE	**$1.60**/lb. U as UF_6	0	0
SWU VALUES			
DOE origin, certifiable as excess, 0.3 tails assay delivery by the end of FY86	**$78**/SWU		
Other SWUs (non-DOE or non-certifiable) delivery by the end of calendar year 1986	**$78**/SWU		
LOAN USE CHARGE RATE	5%/annum	2,000	0

TRANSACTION VALUE	$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
	16.25	2.1	12	4

[1]Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **UF_6 Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.
3. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
4. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
5. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
6. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the DOE SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at a tails assay of 0.30 weight-percent U_{235} and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to the Nuexco Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

© NUEXCO 1985

NUEXCO

CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)
Australia (dollar)	24.31	23.51	17.99	63.20	61.13	46.77
Belgium (comm. franc)	861.18	873.94	959.16	2,239	2,272	2,494
Canada (dollar)	23.08	22.55	20.49	60.01	58.63	53.27
Finland (markka)	91.63	92.54	99.17	238.22	240.59	257.82
France (franc)	129.85	132.32	145.95	337.57	344.00	379.44
FRG (mark)	42.62	43.43	47.74	110.80	112.91	124.10
Italy (lira)	28,741	29,188	29,451	74,719	75,882	76,566
Japan (yen)	3,368	3,507	3,811	8,755	9,119	9,908
Netherlands (guilder)	47.82	48.79	53.65	124.31	126.84	139.48
South Africa (rand)	44.14	42.04	28.62	114.75	109.29	74.42
Spain (peseta)	2,625	2,647	2,663	6,825	6,883	6,923
Sweden (krona)	128.55	129.62	135.85	334.20	336.97	353.17
Switzerland (franc)	35.06	35.56	39.17	91.14	92.45	101.84
UK (pound)	11.41	11.51	12.88	29.66	29.91	33.50
US (dollar)	16.75	16.50	15.50	43.55	42.90	40.30

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)
Australia (dollar)	22.93	22.45	18.46	59.62	58.35	47.98
Belgium (comm. franc)	812.34	834.22	983.91	2,112	2,168	2,558
Canada (dollar)	21.77	21.53	21.02	56.60	55.97	54.65
Finland (markka)	86.43	88.83	101.73	224.71	229.65	264.47
France (franc)	122.48	126.30	149.72	318.42	328.36	389.23
FRG (mark)	40.20	41.46	48.97	104.52	107.78	127.31
Italy (lira)	27,110	27,861	30,211	70,481	72,433	78,542
Japan (yen)	3,177	3,348	3,910	8,258	8,704	10,164
Netherlands (guilder)	45.10	46.57	55.04	117.26	121.07	143.08
South Africa (rand)	41.63	40.13	29.36	108.24	104.32	76.34
Spain (peseta)	2,476	2,527	2,731	6,438	6,570	7,101
Sweden (krona)	121.26	123.72	139.35	315.25	321.65	362.28
Switzerland (franc)	33.07	33.94	40.18	85.97	88.25	104.46
UK (pound)	10.76	10.98	13.22	27.98	28.55	34.36
US (dollar)	15.80	15.75	15.90	41.08	40.95	41.34

[1]Calculated using currency exchange rates published in the *Wall Street Journal* on November 29, 1985.

© NUEXCO 1985

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6			per kg. U as UF_6		
	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)	This Month (Nov. 30, 1985)	Last Month (Oct. 31, 1985)	12 Months Ago (Nov. 30, 1984)
Australia (dollar)	2.32	2.28	0.93	5.12	5.03	2.05
Belgium (comm. franc)	82.26	84.75	49.51	181.36	186.83	109.14
Canada (dollar)	2.20	2.19	1.06	4.86	4.82	2.33
Finland (markka)	8.75	8.97	5.12	19.30	19.78	11.28
France (franc)	12.40	12.83	7.53	27.34	28.29	16.61
FRG (mark)	4.07	4.21	2.46	8.98	9.29	5.43
Italy (lira)	2,745	2,830	1,520	6,052	6,239	3,351
Japan (yen)	321.67	340.14	196.71	709.17	749.87	433.66
Netherlands (guilder)	4.57	4.73	2.77	10.07	10.43	6.10
South Africa (rand)	4.22	4.08	1.48	9.29	8.99	3.26
Spain (peseta)	250.78	256.74	137.43	552.88	566.01	302.99
Sweden (krona)	12.28	12.57	7.01	27.07	27.71	15.46
Switzerland (franc)	3.35	3.45	2.02	7.38	7.60	4.46
UK (pound)	1.09	1.12	0.67	2.40	2.46	1.47
US (dollar)	1.60	1.60	0.80	3.53	3.53	1.76

SWU VALUES AND UF_6 VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU Delivery by the End of FY86 (November 30, 1985)	Non-DOE SWU Delivery by the End of CY86 (November 30, 1985)	UF_6 Value per kg. U in UF_6 This Month (November 30, 1985)	UF_6 Value per kg. U in UF_6 Last Month (October 31, 1985)
Australia (dollar)	113.21	113.21	66.76	65.56
Belgium (comm. franc)	4,010	4,010	2,365	2,436
Canada (dollar)	107.48	107.48	63.39	62.88
Finland (markka)	426.70	426.70	251.64	257.99
France (franc)	604.65	604.65	356.59	368.89
FRG (mark)	198.47	198.47	117.05	121.08
Italy (lira)	133,837	133,837	78,929	81,372
Japan (yen)	15,682	15,682	9,248	9,778
Netherlands (guilder)	222.67	222.67	131.32	136.01
South Africa (rand)	205.53	205.53	121.21	117.20
Spain (peseta)	12,226	12,226	7,210	7,381
Sweden (krona)	598.62	598.62	353.03	361.35
Switzerland (franc)	163.25	163.25	96.27	99.14
UK (pound)	53.13	53.13	31.34	32.08
US (dollar)	78.00	78.00	46.00	46.00

[1]Calculated using currency exchange rates published in the *Wall Street Journal* on November 29, 1985.

© NUEXCO 1985

NUEXCO

CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current Exchange or UF_6 Value	Seller	Buyer	Remarks
3616	1986	101-300	97	Trader	US Utility	

Enrichment Services Secondary Market Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity[2] (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Seller Group	Buyer Group	SWU Origin	Remarks
3617	1986	less than 50	101-103	European Utility	US Utility	DOE	

[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2] If tails assay is unknown or unspecified, Nuexco's calculation of SWU quantity assumes 0.30 w/o tails assay.
[3] Price is not normalized to 0.30% tails assay.
[4] Refers to SWU Value that corresponds to SWUs included in transaction. When prices and SWU values are expressed as discounts (e.g., X dollars less than DOE's USEC base price at time of delivery), the percentage refers to the ratio of the *discounts*, not the ratio of the prices.

© NUEXCO 1985

CURRENT MARKET DATA

URANIUM SUPPLY
(November 30, 1985)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1860*	500	500	UF_6
2335*	275	—	
2483	70	—	
2728	350	—	
2737	120	200 per year	1986-92
2740*	200	—	
2771*	100	—	
2793	1,000	—	
2802*	200	—	
2814	500	500	UF_6
2907*	300	—	
2263	—	400 per year	1987 on
2625	—	500 per year	1987 on
2680	—	500 per year	1986-92
2778	—	220 per year	1987-90
2781*	—	100 per year	1988-95
TOTAL:	3,615		
INACTIVE			
2336	250	250 per year	1985-94
2389	75	75 per year	1986-90
2654*	300	700 per year	UF_6
2746*	180	—	UF_6e
2764*	260	—	UF_6
2765*	260	—	UF_6
2777	250	—	
2804	100	—	
2825*	100	—	
2297	—	200 per year	1986-89
TOTAL:	1,775		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2705, 2711.

© NUEXCO 1985

NUEXCO

CURRENT MARKET DATA

URANIUM DEMAND
(November 30, 1985)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2743*	325	—	UF_6
2748*	75	—	
2758*	1,000	500	UF_6
2762*	300	—	
2769*	400	—	
2784	100	—	
2798	70	—	
2217	—	1,000 per year	1989-95
2507	—	600	1987-89
2586*	—	250 per year	1988-95
2681	—	500 per year	UF_6 or U_3O_8; 1987-88
2733	—	500 per year	1987-95
2738*	—	1,000	1989 on
2739*	—	1,000 per year	1987-90
2760	—	750 per year	1986-90
2770*	—	400 per year	1988-94
2796	—	175 per year	1988-92
2808	—	250	1989 on
TOTAL:	2,270		
INACTIVE			
2548	290	—	
2772*	750	—	
2786	200	—	
2806*	1,500	—	
2643	—	150 per year	1987 on
TOTAL:	2,740		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2741, 2753, 2767, 2775.

© NUEXCO 1985

CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(November 30, 1985)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
2805	2,000	—	
TOTAL:	2,000		
INACTIVE			
1938	2,000	—	UF_6
2036	500	—	
2667	800	—	
TOTAL:	3,300		

*New or revised since last month.
[1]Measured from the date of this Report.
Projects removed since last month: None.

No inquiries to borrow are reported this month.

CONVERSION SUPPLY AND DEMAND
(November 30, 1985)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
INACTIVE			
2051	100	—	
TOTAL:	100		
Inquiries to Purchase:			
INACTIVE			
2724	—	375	1989-93
TOTAL:	0		

*New or revised since last month.
[1]Measured from the date of this Report.
Projects removed since last month: 2623.

© NUEXCO 1985

NUEXCO

CURRENT MARKET DATA

SWU SUPPLY AND DEMAND
(November 30, 1985)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2410A	350	—	
2705	350	—	
2571	—	55	1987
TOTAL:	700		
INACTIVE			
2652	—	25	1986
2746*	100	—	
TOTAL:	100		
Inquiries to Purchase:			
INACTIVE			
2400	—	150	1987-90
2761	115	—	
2797	—	150	1988-89
TOTAL:	115		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2742, 2752.

© NUEXCO 1985

BELGIUM

Introduction

The final two units in Belgium's seven-unit nuclear power program recently have entered commercial service, ending that nation's nuclear construction phase. Belgium is the second European country to end its plant construction phase in 1985. (During 1985, Swedish utilities also commissioned the final two units in their twelve-unit program, Forsmark Unit 3 and Oskarshamn Unit 3.) Belgium's Doel Unit 4 and Tihange Unit 3 reached full power on June 20 and July 23, respectively. Both units are 980-MWe PWRs supplied by the consortium ACECON (comprised of Westinghouse and the Belgian companies Cockerill and Ateliers de Constructions Electriques de Charleroi SA [ACEC]). According to preliminary figures, during October 1985, the seven nuclear power units produced 80 percent of the country's electricity.

No plans for other units on Belgian territory have materialized to date, although the country's energy companies are discussing the installation of an eighth unit before the end of this century. In the interim, Belgian utilities and industrial groups are participating in the first unit of the Chooz B project under construction in northern France, in accordance with agreements reached in 1984 with Electricité de France (EDF) and French manufacturers. In recent decades, Belgium has been a strong advocate of European cooperation in economic and technical projects. Brussels is the seat of Euratom, the European Community's nuclear energy treaty organization, and Belgium is a participant in Eurodif and several other European nuclear energy projects. Like most countries in Europe, Belgium lacks adequate uranium resources. It imports a share of its requirements from each of the major uranium exporting regions of the free world.

Political Economy

The kingdom of Belgium is located in the center-west corner of Europe between the Netherlands, France, and the Federal Republic of Germany (Figure 1). The country has a population of 10 million, of whom some 59 percent speak Dutch and 41 percent speak French. The Doel nuclear power station is located in the Flemish (Dutch-speaking) region near the border with the Netherlands, and the Tihange station is located in the French-speaking region of Liege. Belgium is densely populated and heavily industrialized, having been for centuries a manufacturing and trading center. It is currently governed by a moderate parliamentary coalition of the Christian Democrat and Liberal parties.

Nuclear energy development began in the late 1960s following the progressive exhaustion of domestic coal resources and the rapid growth of electricity demand. The program was accelerated in the early 1970s due to the increasing cost of primary energy imports, oil products in particular. The first nuclear unit entered service in August 1975; by the end of 1985, the seven operating reactors will supply nearly 20 percent of all primary energy consumed in Belgium, and over 60 percent of total electricity consumed. The country now consumes only two-thirds the quantity of oil it used a decade ago.

Utility Structure

Table 1 lists Belgium's seven operating units, four of

Table 1

NUCLEAR POWER UNITS IN BELGIUM

Unit	MWe	Type	COD[1]	Operating Utility
Doel 1	392.5	PWR	Jan 1975	Ebes[2]
Doel 2	392.5	PWR	Dec 1975	Ebes
Doel 3	900	PWR	Sep 1982	Ebes
Doel 4	980	PWR	Jul 1985	Ebes
Tihange 1	870	PWR	Sep 1975	Intercom[3]
Tihange 2	900	PWR	Jun 1983	Intercom
Tihange 3	980	PWR	Oct 1985	Intercom
	5,415			

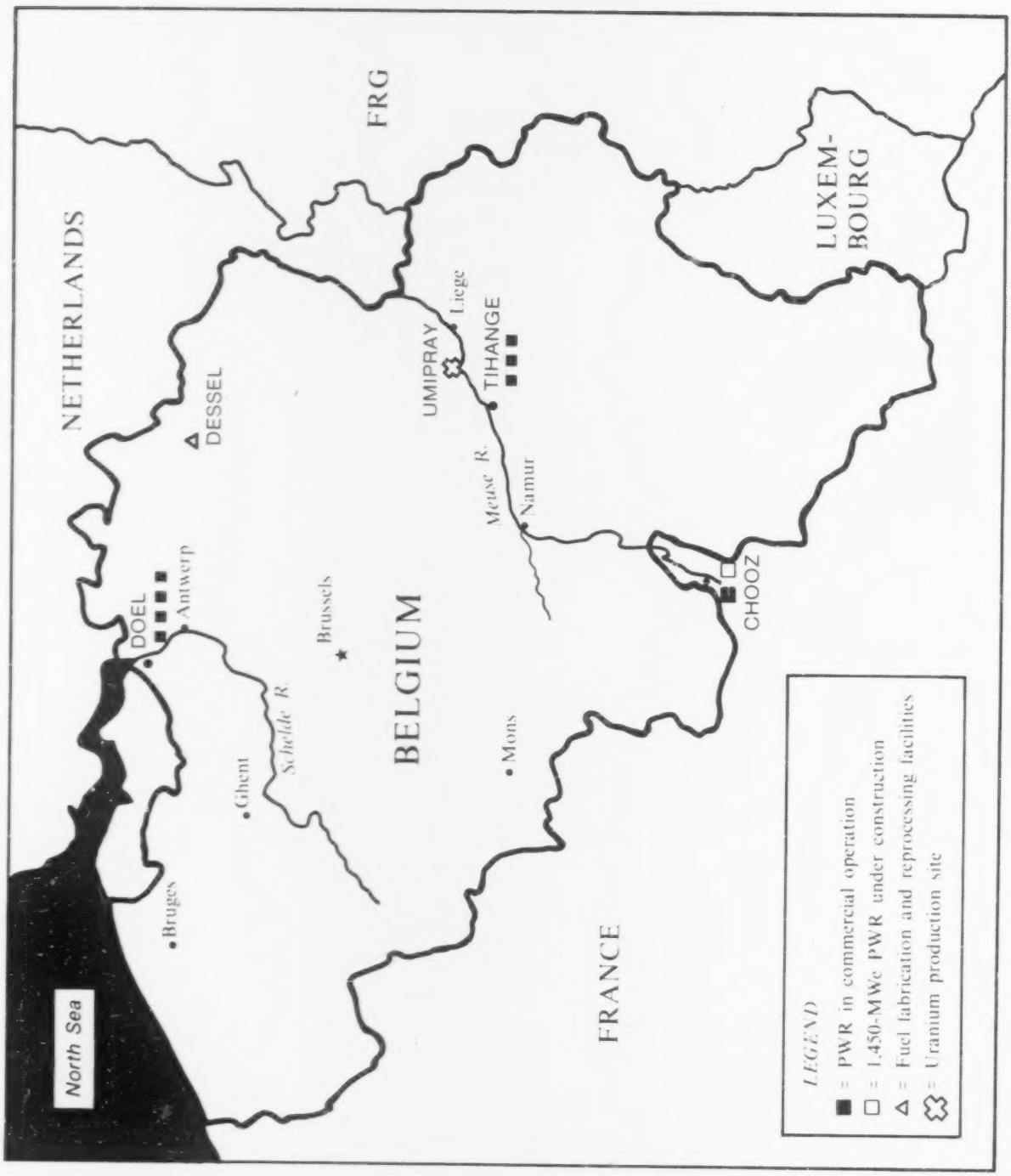
[1]COD = Commercial Operation Date.
[2]Ebes = Société Reunies d'Energie du Bassin de l'Escaut.
[3]Intercom = Société Intercommunale Belge de Gaz et d'Electricité.

NUEXCO

FOCUS

Figure 1

NUCLEAR FUEL CYCLE FACILITIES IN BELGIUM



© NUEXCO 1985

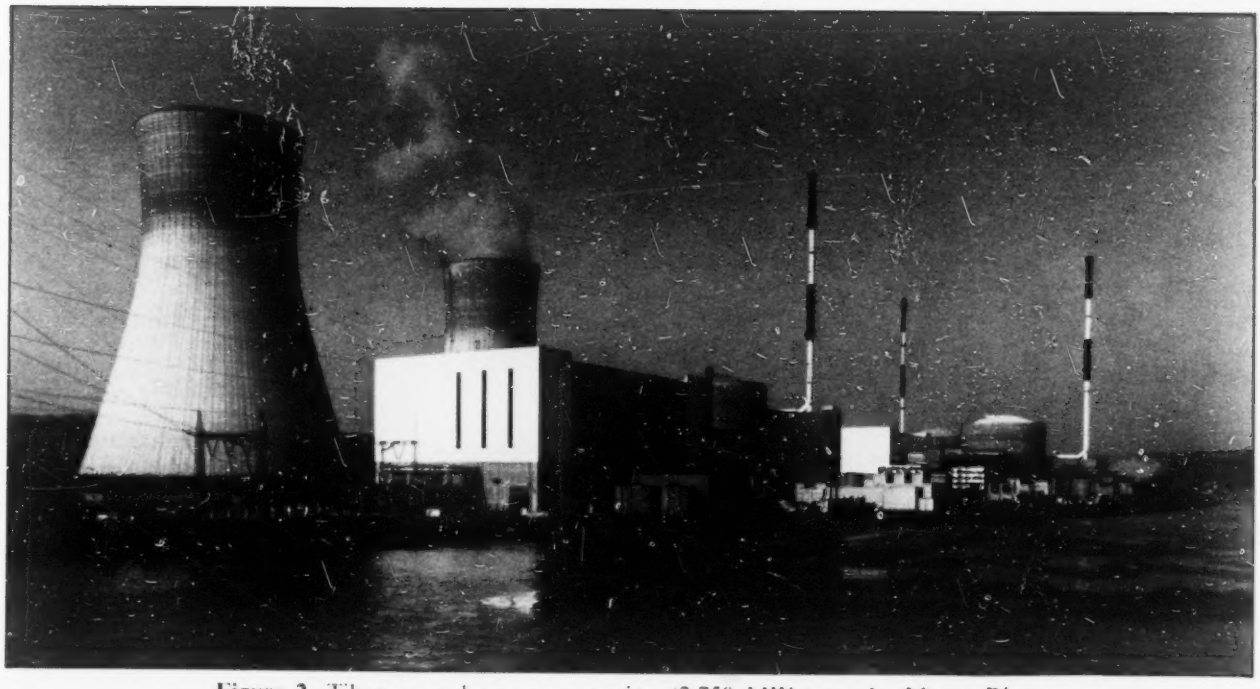


Figure 2. Tihange nuclear power station (2,750 MWe) on the Meuse River.

them located at the Doel station and three at the Tihange station (Figure 2). The principal owners of the units are the utilities Intercom (Société Intercommunale Belge de Gaz et d'Electricité), Ebes (Société Réunies d'Energie du Bassin de l'Escaut), and Unerg, which together produce approximately 95 percent of the electricity generated and consumed in the country. Intercom is the second largest company traded on the Belgian stock exchange; Ebes is the third largest, and Unerg the eighth largest. Ebes is the operating utility at the Doel station and owns the largest share in each of the station's four units; Intercom is the operator at Tihange, owning 100 percent of Tihange Units 2 and 3. EDF owns 50 percent of Tihange Unit 1, with the three Belgian utilities sharing the balance. The average capacity factor in 1984 for the five Belgian units then operating was 86.9 percent.

Belgium's two largest financial groups, Société Générale de Belgique (SGB), and Groupe Bruxelles Lambert (GBL), indirectly own large shareholdings in the three national utilities. Their shares are held through Tractionel and Electrobel, two holding companies with large electrical engineering divisions. The engineering division of Tractionel was the architect-engineer for all construction at the four-unit Doel station; the same division in Electrobel built the three-unit Tihange station. Tractionel and Electrobel are expected to consolidate activities in December 1985.

The Belgian utilities have cooperated with EDF in the Chooz A and B projects (Figure 1 and Table 2) as well as in Tihange Unit 1. Chooz Unit A, a 310-MWe PWR that began operation in 1967, is owned and operated by SENA (Société d'Energie Nucléaire Franco-Belge des Ardennes SA). SENA's shares are held jointly by EDF and the three Belgian utilities, in the same proportions as the ownership of Tihange Unit 1. In 1984 construction began on Chooz Unit B1, a 1,450-MWe PWR, after two agreements between Belgium and France were signed. Under one accord, the Belgian utilities will take 25 percent of the power from Chooz Unit B1 at cost, in exchange for selling at cost to EDF 50 percent of the power from the next Belgian unit. Under the second accord, 22.5 percent of the construction orders for Chooz Unit B1 are going to Belgian industry, in exchange for a similar arrangement for French manufacturers when the next Belgian unit is built.

The Belgian utilities also have an arrangement with EDF to take at cost 12.5 percent of the power from EDF's 3,660-MWe Tricastin station. That arrangement is part of Belgian ownership in the enrichment consortium Eurodif.

© NUEXCO 1985

Table 2

BELGIAN ELECTRICITY SHARES FROM EXTERNAL NUCLEAR POWER STATIONS

Station	Operating Utility	Percent Complete	Plant Capacity (MWe)	Belgian Share (percent)	Belgian Share (MWe)
Chooz A	SENA[1]	100	305	50.0	152.5
Chooz B1	EDF[2]	20	1,450	25.0	362.5
Tricastin	EDF	100	3,660	12.5	458.0
Kalkar	SBK[3]	90	295	14.5	42.8
TOTAL MWe					1,015.8

[1]SENA = Société d'Energie Nucléaire Franco-Belge des Ardennes.
[2]EDF = Electricité de France.
[3]SBK = Schnell-Bruter Kernkraftwerksgesellschaft mbH.

The Tricastin station, consisting of four 915-MWe PWRs, was built next to the Eurodif plant at Pierrelatte, France, in order to provide power to Eurodif's four large diffusion halls. (Eurodif is EDF's largest industrial customer, having the capacity to produce 10.8 million SWUs per year.) Each of the four international owners in Eurodif (Table 3) is entitled to a share of Eurodif production capacity that includes power from Tricastin. In another joint European venture, the Belgian government and private interests own 14.5 percent of the Kalkar SNR-300 Fast Breeder Reactor (FBR) project. British and Dutch interests, along with several West German utilities, are other owners in Kalkar. Kalkar is located on the Rhine River in the Federal Republic of Germany, near the border with the Netherlands.

Table 3

OWNERSHIP OF EURODIF

Company	Country	Percent Share
Cogema	France	36.53
Sofidif[1]	France/Iran	25.00
Synatom	Belgium	11.11
Enusa	Spain	11.11
Agip Uranio	Italy	8.125
CNEN[2]	Italy	8.125

[1]Sofidif = Société Franco-Iranienne Pour l'Enrichissement de l'Uranium par Diffusion Gazeuse. Owners are Cogema (60 percent) and the Iran Atomic Energy Organization (40 percent). Cogema manages the Eurodif shareholding; the Iranian nuclear power program has been deferred since the 1979 revolution.
[2]CNEN = Comitat Nazionale per l'Energia Nucleare.

Synatom

Fuel procurement for and management of the seven Belgian nuclear reactors (except for fabrication and in-core management) is handled by Synatom SA, located in Brussels. The Belgian nuclear fuel company was founded by the utilities in 1969 to coordinate a variety of nuclear power projects; in 1977, the articles of the company were modified to direct its focus to the nuclear fuel cycle. In 1983, the government acquired a 50-percent interest in Synatom through the state company SNI (Société Nationale d'Investissement). The current ownership is listed in

© NUEXCO 1985

Table 4. Synatom owns the nuclear fuel used in the Doel and Tihange stations before, during, and after burnup. All costs incurred by the company are paid by the Belgian utilities.

Table 4

OWNERSHIP OF SYNATOM

Company	Percent Share
SNI[1]	50
Ebes[2]	20
Intercom[3]	20
Unerg	10

[1]SNI = Société Nationale d'Investissement.
[2]Ebes = Société Réunies d'Energie du Bassin de l'Escaut.
[3]Intercom = Société Intercommunale Belge de Gaz et d'Electricité.

Aside from some small phosphate by-product production (40 MTU per year), Belgium produces no uranium domestically. Synatom conducts a policy of supply diversity, purchasing uranium under long-term contracts from mines in Australia, Canada, South Africa, and Central Africa. To date, the company has not made any direct investments in overseas production operations. Synatom's total requirements approach 900 MTU as U_3O_8 (2.3 million pounds) per year, and at least two years' forward consumption is kept in inventory. Most conversion requirements are covered by Comurhex, except for Canadian uranium converted at Eldorado and a small contract with British Nuclear Fuels Ltd. (BNFL). Synatom now takes almost all its enrichment requirements from Eurodif, though it still has a small supply contract with the USSR and three dormant Requirements-type contracts with the US DOE.

Synatom is also responsible for the storage and reprocessing of spent fuel. As of the end of 1984, approximately 1,200 spent fuel elements had been withdrawn from Belgian units, some 800 had been shipped to the Cogema plant at La Hague, and some 250 (90 MTU) had been reprocessed. Synatom has contracts with Cogema to reprocess between 500 and 600 MTU through 1990. The uranium recovered from reprocessing will be re-used in PWRs, while the plutonium will be used in mixed-oxide (MOX) fuel assemblies in PWRs or in the FBRs at Kalkar and Creys-Malville, France. The company Belgonucleaire, which has an ownership structure identical to that of Synatom, constructs MOX fuel assemblies at a plant in Dessel, Belgium. The plant has the capacity to próduce 30 to 35 MTU as heavy metal (U and Pu) per year. Most of the standard fabrication for the Belgian PWRs is done by FBFC (Société Franco-Belge de Fabrication de Combustible), a Westinghouse licensee that operates a plant at Dessel with a capacity of 400 MTU per year.

Belgium's Eurochemic reprocessing facility, also located at Dessel, has been out of service since 1974. The government voted in 1983 for bring the plant back into operation for commercial use by Synatom. Synatom has created a subsidiary called Belgoprocess to develop the domestic operation, and is cooperating in this endeavor with Cogema and the German company DWK (Deutsche Gesellschaft fur Wiederaufarbeitung von Kernbrennstoffen mbH). The Eurochemic facility could be in operation around 1990. Final waste disposal in Belgium is regulated by ONDRAF (Organisme National des Déchets Radioactifs et des Matières Fissiles), a government agency created by law in 1980 and funded by the utilities. A waste vitrification demonstration plant has been built by a German group at Dessel, but the issue of final waste storage in Belgium is still undecided.

© NUEXCO 1985

NUEXCO

RECENT DEVELOPMENTS

AUSTRALIA

Under the joint venture agreement between Western Mining Corporation and BP Australia, a decision is due by December 7, 1985 both on the final commitment to develop the Olympic Dam (Roxby Downs) project and on the project's construction schedule. While it has been expected the partners would commit to the project at that time, it has been suggested the commitment date may be delayed to allow the partners additional time to secure contracts for the uranium output. It has been widely reported that the Australian floor price (approximately US$31.00) was proving a serious limitation to concluding uranium sales from the project. Consequently, there were reports that officials were considering eliminating the floor price, lowering it, or reinterpreting it in some fashion that would ease the concerns of potential buyers. As might be expected, Australian government sources characterized such reports as being without foundation. A positive decision to proceed with the Olympic Dam project would lend important support to the South Australian government, which faces an upcoming election. Recently the state government granted the partners special license to draw water from the Great Artesian Basin to meet initial project requirements.

The Director General of the European Commission responsible for energy, on a recent visit to Australia, commented that Australia could be filling one-quarter of the EC's uranium needs by the end of the century. By present estimates this projection would require Australian sales in Europe to increase from 2 million pounds to 8 million pounds U_3O_8 per year. (Table 5 shows Australian uranium production and export figures for the past three financial years.) This would clearly suggest the startup of Roxby Downs production, provided the buyers can be assured that Australia will be a reliable long-term supplier. The floor-price policy and the government-imposed moratorium on uranium exports to France undoubtedly have caused some European buyers to regard Australian supply with serious reservations.

Table 5

AUSTRALIAN PRODUCTION AND EXPORT
(Millions of pounds U_3O_8)

Financial Year Ending June 30	Production	Export
1984-85	9.54	7.53
1983-84	9.66	7.40
1982-83	10.10	9.26

© NUEXCO 1985

SURFICIAL URANIUM DEPOSITS—PART 1

The worldwide search for uranium has resulted in the discovery and recognition of many unconventional uranium occurrences. This is the first of a two-part article on surficial uranium deposits.

Introduction

Surficial uranium deposits occur in a variety of geologic environments dated from Tertiary to Recent ages. These deposits were essentially overlooked by early explorationists because of unusual geologic and mineralogic characteristics. One characteristic is *associated radioactive disequilibrium*, a condition that can occur in deposits when uranium accumulation is so recent that the breakdown of radioactive daughter products, principally Radium 226, is incomplete. The level of radioactive equilibrium in the Tertiary deposits varies widely, from about 0.40 to 1.20, where 1.00 represents equilibrium. In more recent deposits the equilibrium factor may be as low as 0.05 to 0.10. Thus, in young deposits the presence of uranium is virtually undetectable using conventional field instruments. In addition, there is no visible evidence of mineralization. Different exploration techniques are necessary for the discovery and delineation of surficial deposits, especially when dealing with deposits of recent age.

A typical deposit is formed in sediments by precipitation, evaporation, and adsorption on organic matter in swamp environments. Mineralized solutions migrating through favorable host material serve as the uranium source in each deposit. Many of these deposits are still developing as the ore-forming process continues; similarly, changing climatic and geologic conditions can deplete surficial deposits. Under some circumstances, the depletion process at one deposit can enhance the development of a new deposit in another location where the mineralizing process may occur under different host conditions.

The existence of surficial uranium has only recently been identified at locations throughout the world. The discovery and detailed studies of the Yeelirrie deposit in Western Australia during the early 1970s resulted in recognition of the economic potential of surficial deposits. Subsequent discoveries were made in Namibia and South Africa, northern Africa, and South America. The first discoveries in North America were recorded in the early 1970s.

Classification of Surficial Deposits

Surficial uranium is found in at least four general geomorphic and climatic settings—arid, wet temperate, tropical, and transitional. Each is further divided into one or more settings specific to local environmental conditions. Any combination of uranium occurrences may be found within a particular controlling environment, so the potential number and type of deposits are extensive. A general classification of surficial uranium deposits is listed in Table 6.

Surficial deposits are further classified by geologic age. Almost without exception, the deposits occur in Tertiary to Recent sediments. The most important deposits are in extremely arid lands and are of Late Tertiary age, followed by lesser deposits in the temperate wetland and tropical environments of Late Tertiary to Recent age. Finally, the youngest and smaller deposits are found in the transitional environments, usually in organic-rich material associated with unconsolidated sediments within a temperate wetland environment of Recent age. Negative radioactive disequilibrium is often common to deposits in all age environments. It varies with age and depositional characteristics of the uranium, but generally, chemical uranium assay values exceed radioactive equivalent uranium.

Uranium Source

Close proximity to uranium-bearing source rocks is required for the formation of surficial uranium deposits. Intrusive basement rocks consisting mainly of granites and metamorphics usually contain well-disseminated uranium in trace amounts. The average uranium content of granites may vary from about 2 to 8 parts per million (ppm), but locally may be many times higher. The uranium content of metamorphic rocks is less consistent than that in granites, but may occur locally in high-grade concentrations. Finally, through the favorable composition of basement source rock, geomorphology, hydrology, geochemistry, and climate, uranium is leached gradually from the source rock and transported to a favorable host environment where uranium accumulation takes place.

Uranium accumulation occurs by any of three methods—precipitation, evaporation, or adsorption. The uranium in almost every case is found in the hexavalent form, resulting from highly oxidized or reducing conditions. Precipitation of uranium more commonly occurs at the interface of subsurface mineral-bearing solutions and a favorable host environment. Uranium accumulation (or depletion) may be a continuous process subject to subtle physical and chemical changes. Changing climatic conditions, especially prolonged dry periods, hasten mineral precipitation. Mineral depletion and reconstitution are influenced by wet climatic conditions and related fluctu-

© NUEXCO 1985

ating water levels.

Companion minerals (vanadium, potassium, molybdenum, etc.) will precipitate out with the uranium and may complicate the uranium deposition/depletion sequence, as well as hampering the recovery process. The most important uranium mineral to form under such conditions is carnotite, a hydrous potassium uranyl vanadate.

Calcrete deposits are foremost examples of surficial uranium deposits formed by the process of precipitation and evaporation in a fluviatile environment. Evaporative uranium is less common than precipitated uranium; however, the latter occurs in playa environments where arid climatic conditions are extreme. Wet periods followed by long dry periods enhance the evaporative process. Surface waters become charged with uranium following initial contact with source rocks, passing into a playa containment area. Evaporation of the water begins immediately and mineral concentration occurs. In addition, uranium carried in ground waters may be brought to the surface through capillary action to replace water lost during evaporation, becoming a secondary source of uranium. Evaporative minerals usually form in thin layers and may be interbedded with debris (sand and silt) carried into the playa each time it is recharged during the wet season.

Table 6

GENERAL CLASSIFICATION OF SURFICIAL URANIUM DEPOSITS[1]

Climate	Environment	Characteristic
Arid	*Fluviatile*	Stream development
	Valley-fill	Channel deposition
	Flood plain	Deltaic/alluvial fan
	Playa	Evaporite basin
	Marsh/bog	Fine sediments/organics
	Pedogenic	Soil profile
	Authigenic	Soil weathered in-place
	Allogenic	Weathered, redeposited
Wetland	*Fluviatile*	Stream development
	Valley-fill	Channel deposition
	Flood plain	Deltaic
	Springs	Deep groundwater source
	Peat/bog	Organic-rich sediments
	Lacustrine	Lake sediments
	Swamps	Marginal accumulation
	Peat/bog	Organic-rich sediments
Tropical	*Lateritic*	Weathered source rocks
	Supergene	Enriched primary ore
	Epigenetic	Filled fractures/joints
	Gossans	Alteration profile
	Supergene	Enriched primary ore
	Epigenetic	Enriched iron/sulfide ore
Transitional	*General*	Combination of deposits
	Peat, bogs, marshes, swamps, etc.	Organic-rich sediments, low radioactivity

[1]Classification table adapted from IAEA-TECDOC-322, Surficial Uranium Deposits, 1984, pages 10 and 244.

© NUEXCO 1985

Any soluble substance contained in the waters will accumulate at the surface as an evaporite or a brine, and may be of economic interest separately or as a by-product. Associated complex salts can influence the process of uranium accumulation, depletion, and reconstitution. Uranium deposits formed by evaporation are usually thin (one to two meters) and may be well stratified with barren sediments. Nevertheless, lateral limits can be extensive. Identification of uranium minerals in evaporative deposits is rare due to the unstable environment; however, schroeckingerite, a water-soluble uranyl carbonate, has been recognized in unconsolidated sediments following hot and dry periods at Lost Springs, in the Red Desert of Wyoming.

The recent surficial uranium deposits are still forming in today's transitional climates (wetlands) where wet and dry seasons prevail. Uranium-charged surface and ground waters pass through shallow unconsolidated sediments containing an abundance of organic debris in a reducing environment. The organic matter may accumulate as a layer of peat, consisting of decomposed logs, leaves, grasses, and moss, or as pieces or matter scattered throughout sediments. As the uranium-bearing solutions filter through, uranium becomes attached to the organic matter through adsorption.

Uranium accumulation may begin at grass roots and extend for several meters downward through the favorable host material. However, uranium is only loosely bonded to the organic matter, resulting in continuous deposition and remobilization. New mineral accumulations occur wherever favorable environments are encountered downstream. In a case of rapidly fluctuating water levels, precipitation of uranium may occur in the fine to medium-grained sediments. Discrete uranium minerals have not been recognized in any deposits, although associated minerals molybdenum and vanadium have been identified in a few. The geologic age of active, organic-related deposits is estimated to be within the last 10,000 years.

Mode of Occurrence

The largest and most stable surficial uranium deposits are found in arid climates in a geologic environment of shallow Tertiary sediments comprised of indurated sand and gravel. Locally, soil accumulations may become part of the favorable environment. The host rock is designated a calcrete due to a calcium carbonate cementing agent precipitated during solution migration. The degree of cementation varies considerably according to the nature of sediments contacted and the geologic stability of the area of interest. A mature calcrete deposit may show layering and vertical zoning of cemented material caused by fluctuations in solution activity due to climatic changes or tectonic adjustments. Other cementing minerals that may further complicate (or moderate) the makeup of a surficial deposit include dolomite, gypsum, ferric oxide, and halite, any one of which can develop independently of calcium carbonate.

The formation of surficial uranium deposits outside of arid climates occurs by the same basic processes. The principal controls are geology, morphology, and climate. Geology and morphology determine the favorable host environment and limiting capacity for the localization of uranium; climate is the main variance and the guide to the type of deposit formed. Climate determines the availability of moisture necessary to activate the release and transportation of uranium to the host area. Thus, deposits formed in wetland and tropical climates generally are smaller and less stable than those formed in arid climates. The mineralization in the former case is subject to constant depletion and redeposition at new locations. In essence, the limitations of wetland and tropical surficial deposits greatly reduce their economic potential.

Deposits classified as transitional may develop in any environment, maintaining many of the same characteristics listed above. One significant difference is the availability of uranium-charged waters making contact with abundant organic-rich sediments. The deposits are small and constitute a limited resource base. An average uranium content of 0.10 percent to 0.20 percent U_3O_8 would be significant; most occurrences average less. In certain deposits, uranium values are known to exceed 1.00 percent U_3O_8. The economic potential of these deposits is questionable due to a lack of understanding and no past history of mining. Exploitation of one deposit located in the state of Washington began in 1983; however, the project is presently on standby due to economic uncertainties in the uranium market.

Exploration Procedures

Exploration techniques for surficial uranium are not as well defined as those for other geologic settings. This is due to the unconventional nature of the occurrence. Explorationists are still learning about surficial deposits, especially those formed in Recent times. However, once the peculiarities of surficial uranium were identified, the development and application of new and modified prospecting techniques began to show success, primarily in the areas of geophysics and geochemistry.

© NUEXCO 1985

The basic exploration approach for surficial deposits includes geologic reconnaissance to identify potential uranium source rocks. Granitic intrusions and related rocks are indications of possible sources. In addition, a favorable geomorphic setting must be identified. In arid climates, large paleodrainage systems (fluviatial and playa environments) in close proximity to source rocks become ideal exploration targets. Both environments are readily identified by aerial photography and geophysical surveys (*Landsat imagery* is the latest exploration tool available.)

The airborne survey is followed by surface reconnaissance of identified target areas. A detailed sampling program of all rock types and surface water is necessary to determine the presence of uranium in the source rock and in any solutions migrating through the uranium source area to sediments in the paleodrainage system. A ground geophysical survey (resistivity and seismic are both effective techniques) helps outline channel configurations, establishing solution flow patterns. Geochemical studies further identify the presence of uranium and other minerals commonly associated with uranium (molybdenum, vanadium, copper, and selenium), enabling geologists to establish the depositional sequence and distribution of uranium.

Radiometric studies are a viable exploration tool for the older, stable deposits, but are ineffective for the young deposits exhibiting low radioactivity. Radiometric evaluation techniques have improved considerably in the past decade. Early scintillation instruments could not distinguish variations in radioactive emissions given off by unstable uranium mineralization, resulting in gross misinterpretation of total uranium resources available in certain deposits.

More recently, relatively accurate evaluation techniques have been developed which eliminate disequilibrium problems. Instrumentation is available which discriminates beta/gamma radiation given off by uranium, thorium, and potassium. The CaF/NaI detector is designed to count both emitters of radioactivity as a measurement of disequilibrium in a uranium sample.

Other instrumentation developed for quantitative analysis of radioactive material is referred to as Low Energy Gamma Spectrometry. This evaluation method measures low energy gamma emissions from the uranium and thorium decay series. Uranium and thorium values are recorded in parts per million; disequilibrium becomes a negligible factor. The instrument is easily adaptable to field use for rapid evaluation of surface samples and drill cuttings.

Radon gas detection methods also have practical application in arid environments. Radon gas is an alpha emitter. Information collected from alpha detectors is converted to radon intensity profile maps showing anomalous concentrations. Each anomaly represents a potential uranium resource area which can be further evaluated by drilling and trenching. Surficial uranium occurrences can be detected with accuracy, but disequilibrium factors of a deposit will affect final interpretation. A radon survey can be useful to outline channel configuration if the nature of mineralization is somewhat consistent.

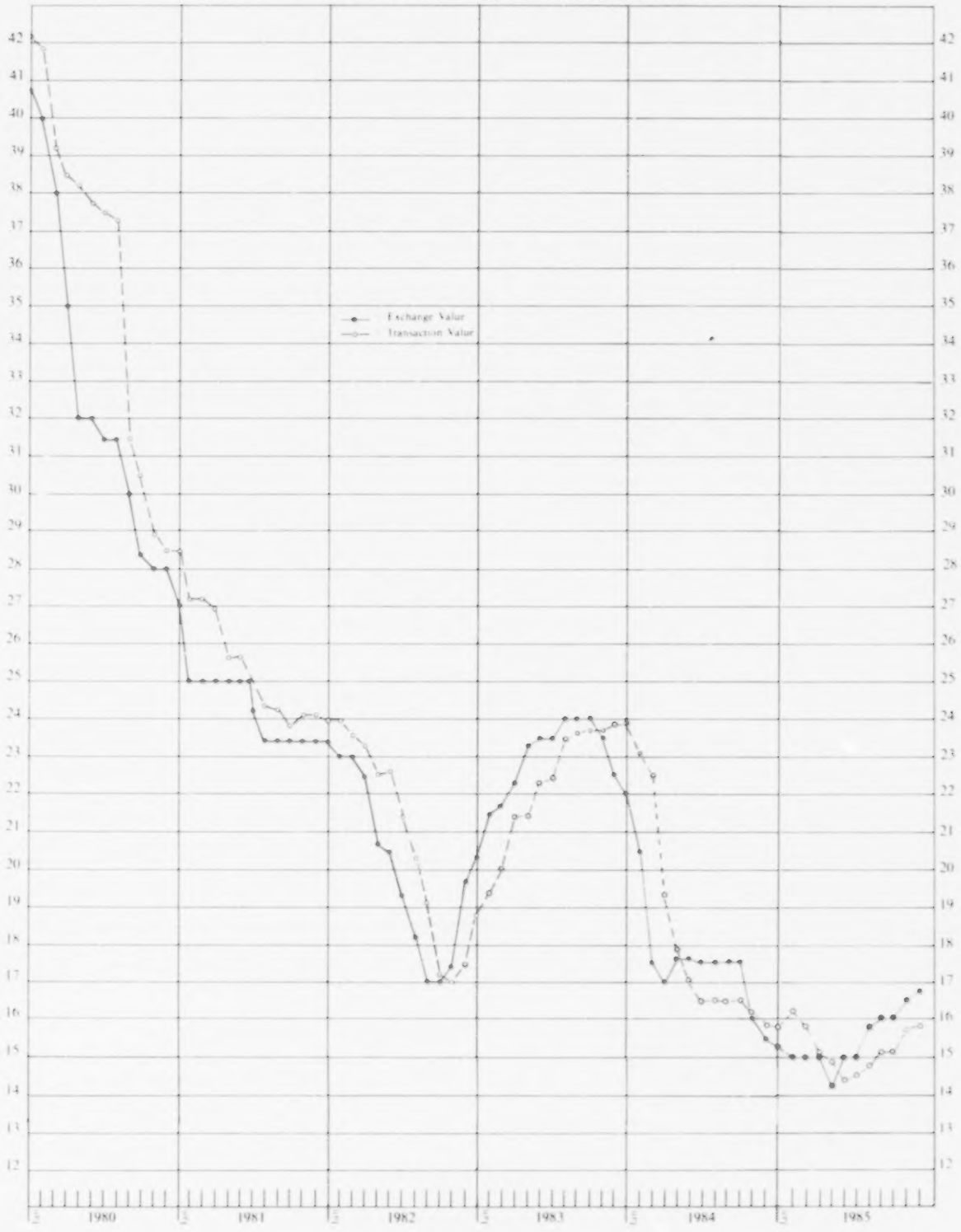
The most reliable exploration procedure is drilling. The drill results will provide three-dimensional evidence of an ore deposit. Nevertheless, special drilling techniques may have to be adopted for best results due to variations in rock type and cementation, the conditions which control mineralization.

Reverse circulation drilling is probably the most common drilling method. This technique utilizes double-walled drill rods wherein compressed air or drilling fluids are forced down the annular space between the two rods. The drill cuttings are returned to the surface through the center rod. All material returned to the surface passes into a special collection device from which samples are taken for further study and chemical assay. Conventional diamond-core drilling and surface excavation work are often essential to support drilling results and to accumulate enough mineralized material for bulk testing and final metallurgical planning. It is a common practice to produce geophysical surveys for each drill hole in order to correlate both geology and mineralization throughout the extent of the deposit.

© NUEXCO 1985

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1980

Determined as of the last day of the month indicated



© NUEXCO 1985

NUEXCO

HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	17.50	17.50	16.00	15.50	15.25
1985	15.00	15.00	15.00	14.25	15.00	15.00	15.75	16.00	16.00	16.50	**16.75**	

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	16.40	16.55	16.05	15.90	15.90
1985	16.20	15.70	15.05	14.90	14.45	14.60	14.75	15.10	15.10	15.75	**15.80**	

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	0.80	1.00	1.00	0.80	0.80
1985	1.00	1.00	1.00	1.50	1.50	1.60	1.60	1.60	1.60	1.60	**1.60**	

© NUEXCO 1985

AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100) (1976=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage and Salary Earners, Weekly Rates[2]
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
1983 Avg.	401.2	181.8
Jan 1984	399.2	188.7
Feb 1984	402.5	188.6
Mar 1984	403.9	188.4
Apr 1984	404.2	196.2
May 1984	403.8	197.0
Jun 1984	404.9	197.4
Jul 1984	408.3	197.4
Aug 1984	413.2	197.4
Sep 1984	411.9	197.4
Oct 1984	408.5	197.4
Nov 1984	407.1	197.4
Dec 1984	406.0	197.4
FY84 Avg.[6]	402.1	—
FY85 Avg.[6]	422.2	—
Jan 1985	409.3	197.4
Feb 1985	416.1	197.4
Mar 1985	430.9	197.4
Apr 1985	440.8	202.3
May 1985	454.4	202.3
Jun 1985	458.9	202.4
Jul 1985	459.0	202.3
Aug 1985	454.9	202.4
Sep 1985	447.7	202.4

P = Preliminary R = Revised since last month

[1]Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).
[2]Australian Bureau of Statistics, Canberra. "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.
[3]Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.
[4]Annual averages prior to 1979 reflect index base no longer in use.
[5]Monthly data for 1979-82 appear on page 35 of Report 184.
[6]Annual averages are for financial year ending June 30.

© NUEXCO 1985

NUEXCO

GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]					
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4] (SIC 296)	(SIC 298)	Chemicals and Chemical Products[5] (SIC 372-379)
1979 Avg.[6]	217.9	—	9.60	9.66	—	—	7.67
1980 Avg.	247.2	—	10.58	10.80	—	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	—	10.63
1983 Avg.	298.8	—	—	14.30	—	—	11.17
Jan 1984	305.4	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.6	17.90	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.7	18.05	15.52	14.82	12.14	10.84	11.58
Apr 1984	310.5	18.06	15.83	15.10	11.96	10.34	11.63
May 1984	310.6	18.48	15.64	15.06	12.11	10.16	11.65
Jun 1984	311.0	18.08	15.48	14.80	12.38	10.40	11.66
Jul 1984	312.9	17.81	15.72	14.92	12.53	10.18	11.82
Aug 1984	312.7	17.24	15.36	14.92	12.44	10.34	11.78
Sep 1984	312.3	17.68	15.96	15.34	12.51	10.52	11.90
Oct 1984	312.3	17.64	16.15	15.26	12.69	10.56	11.96
Nov 1984	313.6	18.04	16.13	15.43	12.47	10.51	11.96
Dec 1984	314.2	17.95	16.39	15.60	12.16	10.40	11.99
1984 Avg.	310.9	17.88	—	15.07	12.28	10.49	11.76
Jan 1985	315.9	18.05	16.13	15.60	12.32	10.80	12.04
Feb 1985	316.5	18.78	16.41	15.68	12.52	11.05	12.06
Mar 1985	318.0	18.24	16.21	15.57	12.44	10.97	12.02
Apr 1985	318.3	18.63	16.44	15.80	12.81	11.23	12.04
May 1985	318.8	19.41	16.51	15.63	12.76	11.25	12.15
Jun 1985	319.1R	18.49	16.20	15.49	12.89	11.14	12.14
Jul 1985	319.4R	18.14	16.19R	15.41R	12.96	11.17	12.13
Aug 1985	319.2R	17.07R	15.76R	15.30R	12.97R	11.31R	12.19R
Sep 1985	319.4R	17.92P	16.16P	15.61P	12.94P	11.38P	12.40P
Oct 1985	320.2P	—	—	—	—	—	—

P = Preliminary R = Revised since last month

[1]Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2]Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3]Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)."

[4]Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[5]Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6]Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7]Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read "Total Mining (SIC 051-099)."

[8]Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing 200 or more wage earners are included in the Wage Earner Data.

© NUEXCO 1985

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1980=100)[4]	Producer Price Index All Groups[5] (1980=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1975 Avg.	16.71	—	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	—	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	—	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	—	137.2	142.7	664,571	1,537,169
1979 Avg.[7]	30.18	—	155.3	164.5	692,209	1,830,632
1980 Avg.[8]	35.53	—	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	—	206.5	218.3	728,506	2,820,505
1982 Avg.[9]	47.25	104.2	233.5	248.7	707,552	3,246,071
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	715,628	342,332
Apr 1984	—	—	286.1	290.2	712,963	327,550
May 1984	—	—	288.3	292.6	710,040	327,937
Jun 1984	56.95	126.2	291.2	295.3	717,009	347,121
Jul 1984	—	—	295.1	296.0	717,121	369,964
Aug 1984	—	—	297.0	300.8	721,905	361,357
Sep 1984	60.64	133.2	299.9	304.1	721,470	359,218
Oct 1984	—	—	303.7	308.7	717,865	363,755
Nov 1984	—	—	307.4	312.8	717,396	369,771
Dec 1984	62.92	138.6	309.4	315.9	701,198	365,234
Jan 1985	—	—	177.1	166.6	711,366	376,777
Feb 1985	—	—	182.8	171.3	727,932	361,823
Mar 1985	64.48	142.4	183.6	173.0	708,809	371,380
Apr 1985	—	—	187.4	174.0	724,187	369,005
May 1985	—	—	189.5	177.7	708,085	373,478
Jun 1985	67.42	148.9	191.9	179.2	724,587	395,543
Jul 1985	—	—	193.6	180.7	738,228	419,106
Aug 1985	—	—	195.6	183.2	734,121	416,777
Sep 1985	70.47	155.3	197.8	184.8	—	—
Oct 1985	—	—	200.8	—	—	—

[1]Chamber of Mines of South Africa, Johannesburg, "Analysis of Working Results," published quarterly.
[2]Page 16 of Report 178 contains description and calculation of index, and page 24 of Report 178 lists figures for 1982.
[3]Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."
[4]The basis for calculation prior to January 1985, 1975 = 100. For annual averages prior to 1978, April 1970 = 100.
[5]Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same. The basis for calculation prior to January 1985, 1975 = 100.
[6]Bulletin of Statistics, Department of Statistics, Pretoria.
[7]Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.
[8]Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.
[9]Monthly data for 1979-82 appear on page 39 of Report 184.

© NUEXCO 1985

NUEXCO

GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8	303.1	298.4	215.63	12.57	13.43	10.59	8.65
Jan 1984	319.1	308.0	305.2	—	12.68	13.37	10.88	8.91
Feb 1984	320.6	308.9	306.6	—	12.83	13.33	10.87	8.91
Mar 1984	321.9	311.0	307.3	220.58	12.89	13.32	10.96	8.94
Apr 1984	322.5	311.4	308.8	—	12.94	13.29	10.94	8.94
May 1984	323.3	311.7	309.7	—	13.02	13.36	11.99	8.94
Jun 1984	323.9	311.4	310.7	222.40	12.99	13.39	11.00	8.97
Jul 1984	324.0	312.0	311.7	—	13.06	13.34	11.09	9.00
Aug 1984	323.5	310.9	313.0	—	13.15	13.50	11.09	9.05
Sep 1984	322.3	309.5	314.5	224.57	13.23	13.38	11.20	9.13
Oct 1984	323.2	309.4	315.3	—	13.26	13.53	11.29	9.15
Nov 1984	323.8	310.4	315.3	—	13.27	13.74	11.31	9.20
Dec 1984	323.0	309.9	315.5	226.10	13.32	13.64	11.34	9.32
1984 Avg.	322.6	310.3	311.1	223.43	13.05	13.43	11.08	9.04
Jan 1985	322.9	309.5	316.1	—	13.29	13.70	11.39	9.33
Feb 1985	322.5	309.2	317.4	—	13.30	13.73	11.39	9.33
Mar 1985	322.6	308.7	318.8	229.07	13.29	13.95	11.37	9.39
Apr 1985	323.8	309.3	320.1	—	13.43	13.62	11.48	9.40
May 1985	325.3	309.8R	321.3	—	13.24	13.59	11.46	9.39
Jun 1985	324.8R	309.2R	322.3	230.55R	13.23	13.66	11.52	9.46
Jul 1985	324.3	309.0	322.8	—	13.45	13.82	11.60	9.47
Aug 1985	323.6	307.2	323.5	—	13.55R	13.69R	11.62R	9.50R
Sep 1985	322.5	305.8	324.5	231.85R	13.45	13.66	11.66R	9.56R
Oct 1985	324.4	308.0	325.5	—	—	—	11.72	9.56

P = Preliminary R = Revised since last month

[1]US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2]US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3]US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4]US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5]Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6]Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

© NUEXCO 1985

NUEXCO

REPRESENTATIVES AND CONSULTANTS

AUSTRALIA

Peter Stork
Oratom Consulting*
5 Gould Ave.
St. Ives
NSW 2075, Australia
Telephone: (61-2) 449-6783
Telex: 23976 (COMTLX)

JAPAN

Kazy Yokota
Japan Tech Services*
Ohkura Building (3F)
1-4-10 Shiba Daimon
Minato-ku, Tokyo, Japan
Telephone: (81-3) 431-6031, 6025
Telecopy: (81-3) 434-6674
Telex: 242-5060 (JATECH J)

SOUTH AFRICA

Chris I. Von Christierson
Southern Prospecting (Pty) Limited*
P.O. Box 61409
Marshalltown 2107
Republic of South Africa
Street Address:
10th Floor
Eagle Star House
70 Fox Street
Johannesburg 2001
Telephone: (27-11) 838-1868
(27-11) 834-4211
Telex: 4-89878 SA

TAIWAN

Edward Bee
Bee & Liang Company, Ltd.*
14 FL Universal Business Center
NO. 663, Tun Hwa South Road
P.O. Box 1396
Taipei, Taiwan R.O.C.
Telephone: (886-2) 704-9630
TWX: 785-11570 (BEELIANG)

UNITED STATES

Harold C. Lindberg*
83-A Hardee Lane
Whispering Pines, N.C. 28327
Telephone: (919) 949-3622

Ralph O. Smith*
141 Braemar Drive
Cheshire, Connecticut 06410
Telephone: (203) 272-6246

SPECIAL CONSULTANTS

James C. C. Stewart
U.K. Nuclear Industry

Claus C. Thiesen
Japan Nuclear Industry

W. Bryan Webster
International Business Development

J. Robert Wolcott
International Business Development

*Independent contractors representing Nuexco